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Observations On the Pelagic Distribution of Seabirds In the Western Indian Ocean

By Frank B. Gill
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In 1952, regarding our knowledge of seabirds, the Indian Ocean was considered to be the least-explored part of the world ocean (Murphy, 1952). The validity of this statement was dramatized soon thereafter by the discovery of two new petrels, *Bulweria fallax* (Jouanin, 1955) and *Pterodroma baraui* (Jouanin, 1963), and an Indian Ocean breeding colony of a third petrel, *Pterodroma arminjoniana* (Murphy and Pennoyer, 1952). Still, the need for information on the pelagic distribution and behavior of seabirds in the Indian Ocean remains (Bourne, 1963), for, although summaries of the scattered accounts are available (Bourne, 1960, 1963; Jouanin, 1957; Watson, Zusi, and Storer, 1963), the information on which they are based comes primarily from well-travelled commercial routes. By contrast, the rest of that ocean has received scant attention.

The International Indian Ocean Expedition (IIOE), a multination endeavor coordinated and sponsored by UNESCO, has been

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making possible the accumulation of seabird observations by scientific personnel aboard oceanographic research vessels that are systematically transecting the entire Indian Ocean. Some of the resulting information has already been published (Bailey, 1964, 1965, 1966; Pocklington, 1965; Pocklington and Risebrough, 1964; Rand, 1962, 1963). The present report is based on observations and collections made by the author during IIOE cruise 5 of the R/V *Anton Bruun* from January through April 1964 and also during a voyage of the commercial vessel S.S. *Kampala* in May 1964.

The cruise tracks of these two voyages are outlined in figure 1 and the details of the itineraries are included in table 1. Cruise 5 of the *Anton Bruun* originated and terminated in Bombay, India, on Jan. 26 and May 4, 1964, respectively and consisted of a direct transit across the Arabian Sea from Bombay to the Gulf of Aden followed by a north-south transect of the western Indian Ocean on longitude 55° E and a south-north transect on longitude 75° E. A direct run from Mauritius to 40° S, 75° E, connected the two transects. The passage from Bombay to the Seychelles from May 17 to June 2, 1964, was a scheduled run of the *Kampala* (British-India Lines) and included stops at Karachi, Mombasa, and Zanzibar.

At each station on the *Anton Bruun*'s itinerary, I maintained a 2–3-hour standardized watch for seabirds from the bridge of the ship. During this period the ship was essentially stationary. In the evening, while in transit to the next day's station at an average speed of 10–12 knots, I counted seabirds again for an hour before dusk. Records also were kept of all birds sighted between watch periods; when I was not on deck, I was alerted to the presence of seabirds by the officers on watch.

The main difference influencing the observations made from the *Kampala* was the continuous movement of the ship (15 knots) and the fact that I could only watch from one side of the ship at a time, narrowing the radius of observation from 360° to slightly less than 180°.

Some seabirds were collected from a small rubber "Zodiac" boat in subantarctic waters and during our brief visits to the Seychelles, Mauritius, Amsterdam, and St. Paul Islands. Although the latter two islands will be included in this report, only those birds seen at sea in the vicinity of the Seychelles and Mascarene Islands are discussed here, as studies on these islands were continued from June to November 1964 and will be published elsewhere.

In the course of this work I have kept detailed notes and descriptions of all unfamiliar seabirds and have found the following references especially useful for identification: "Birds of the Ocean" (Alexander, 1954), "The Petrels of the Indian Ocean" (Bourne, 1960), "A Preliminary Field Guide to Birds of the Indian Ocean" (Watson, Zusi, and

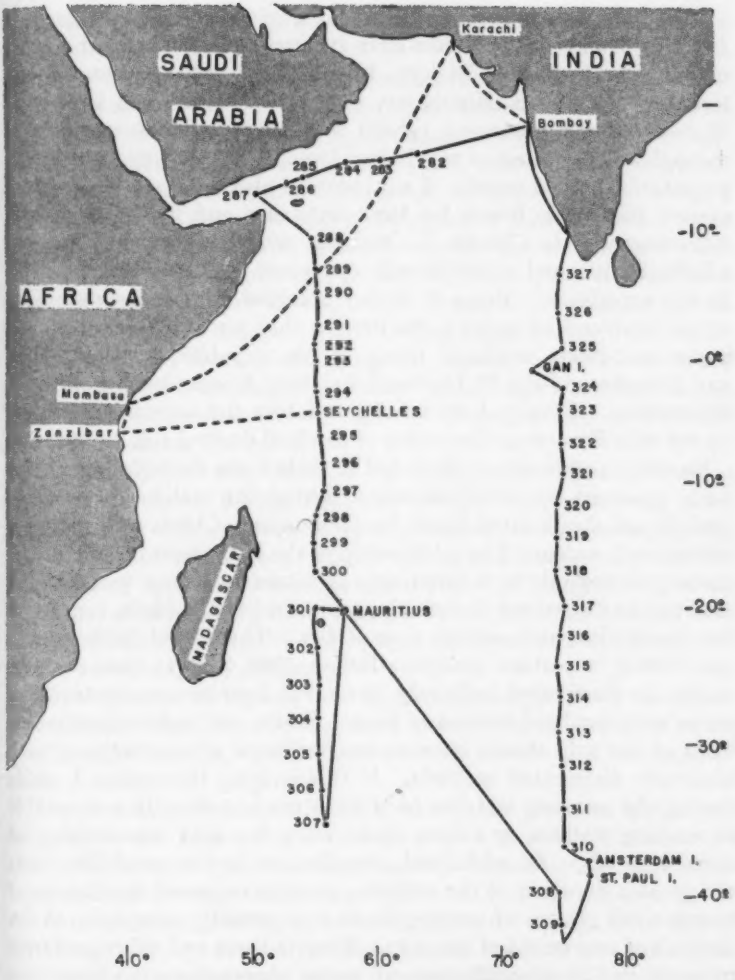

FIGURE 1.—Cruise tracks and station positions.
——— R/V *Anton Bruun:* Jan. 26 to May 4, 1964
------ T.S.S. *Kampala:* May 17 to June 2, 1964

Storer, 1963). The nomenclature used follows that of Peters (1931, 1934) except in a few cases wherein recent revisions or descriptions were applicable. All specimens have been cataloged in the collections of the U.S. National Museum in Washington, D.C.

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SEABIRD ABUNDANCE.—Included in table 1 are the numbers of seabirds (grouped by order) observed during the standardized watch periods and a calculated figure for the number of birds seen per hour during each watch. The relationship of the latter figure to the actual density of seabirds in a given area is biased by many variables including the movement of the ship, movement of the birds, conditions for observation, and perhaps time of day. The first of these may be particularly important (compare Bailey, 1966, p. 261) since seabirds rarely are distributed uniformly at sea but instead congregate at and move with localized sources of food. Hence, any substantial movement of the ship should increase the likelihood of encountering nonrandomly distributed seabirds. If this is true, the counts I made during the morning watches on station are not directly comparable to evening watches or others made when the ship was cruising at normal speeds. An additional complication is the possibility that the greater duration of the morning watches increased the chances of seeing small groups of moving birds and partially compensated for the lack of movement of the ship. Despite these and other problems inherent in the quantification of at-sea observations, at least five regions were found where seabirds were more common than in the intervening areas. These were: (1) the western Arabian Sea and south along the coast of Somalia; (2) the Seychelles Islands and surrounding seas; (3) the waters near the Mascarene Islands; (4) subantarctic waters below 33° S; (5) the seas east of the Maldive Islands and north to the Indian coast. A sixth region near the equator also might be distinguished though the increase there was less pronounced than in the other areas. In these regions the number of seabirds seen per hour was definitely greater than 2–3, usually 10–30, and on some occa-

sions reached 100–200.[2] In the intervening seas an average of one bird or less was seen per hour.

REGIONAL SUMMARIES.—In the Arabian Sea, Jouanin's petrel (*Bulweria fallax*) and the red-billed tropicbird (*Phaëthon aethereus*) were the two species most commonly encountered in January although, close to the Gulf of Aden and Socotra, Audubon's shearwaters (*Puffinus lherminieri*) were quite common and the lesser black-backed gull (*Larus fuscus*), Aden gull (*Larus hemprichii*), masked booby (*Sula dactylatra*) and brown booby (*Sula leucogaster*) also were found. The primary difference within this general region in the following May was the appearance of several storm petrels, i.e., Wilson's petrel (*Oceanites oceanicus*), frigate petrel (*Pelagodroma marina*), and either the white-bellied storm petrel (*Fregetta grallaria*) or the black-bellied storm petrel (*Fregetta tropica*). Storm petrels also were seen at this time south along the African coast to Mombasa and east to the Seychelles Islands (see table 4).

Most of the breeding seabirds of the Seychelles Islands forage in large mixed flocks in the relatively shallow waters around these islands. Few species, however, except the sooty tern (*Sterna fuscata*) and the wedge-tailed shearwater (*Puffinus pacificus*), stray into the surrounding open seas with any regularity. Although flocks of up to several hundred sooty terns were seen near the Seychelles and east to the African coast in May and June, no sooty terns were seen in this region in January and February.

In the equatorial regions two all-dark storm petrels of uncertain identification (possibly *Oceanodroma monorhis* and *O. matsudairae;* see "Species Accounts") were encountered, as well as a tern, apparently the fairy tern (*Gygis alba*).

The numbers of seabirds found in the waters near the Mascarene Islands seemed impressive to me after having passed through the relatively barren region south of the Seychelles Islands. Flocks of sooty terns and wedge-tailed shearwaters, as well as scattered white-tailed tropicbirds (*Phaëthon lepturus*), appeared within 50 miles of Mauritius. A few common noddies (*Anous stolidus*) also were seen. Further to the southwest, Barau's petrel (*Pterodroma baraui*) from Reunion was a common pelagic species, occurring with tropicbirds (*P. lepturus*) and Audubon's shearwaters (*Puffinus lherminieri*).

Below 34° S we encountered the albatrosses and petrels, characteristic of the cool water oceans of the southern hemisphere. The wandering albatross (*Diomedea exulans*), white-chinned petrel (*Procellaria aequinoctialis*), soft-plumaged petrel (*Pterodroma mollis*), and

[2] The increase near the Maldives was only subjectively apparent, as standardized watches permitting computations of birds seen per hour were not made in this region.

prions (*Pachyptila*) were the most abundant and conspicuous species while others such as the sooty albatross (*Phoebetria fusca*), shy albatross (*Diomedea cauta*), black-browed albatross (*Diomedea melanophris*), yellow-nosed albatross (*Diomedea chlororhynchos*), and great-winged petrel (*Pterodroma macroptera*) were seen regularly but in smaller numbers. Scattered individuals of only six other species were seen at sea in this region: Schlegel's petrel (*Pterodroma incerta*), giant petrel (*Macronectes giganteus*), pediunker (*Adamastor cinereus*), sooty shearwater (*Puffinus griseus*), Wilson's petrel (*Oceanites oceanicus*), and white-bellied storm petrel (*Fregetta grallaria*).

St. Paul and Amsterdam Islands were once very important seabird breeding stations (Jouanin, 1953; Murphy and Irving, 1951). During cruise 5 of the *Anton Bruun*, we visited each of these islands briefly, St. Paul for a few hours in the late afternoon of Apr. 7 and Amsterdam Island the following day. Seabirds were numerous in the waters around both of these islands and included most of the common petrel and albatross species seen elsewhere at sea in this region; however, sooty albatrosses and white-chinned petrels were especially numerous near Amsterdam Island. Flocks of Antarctic terns (*Sterna vittata*) were feeding near both islands and, within one mile of St. Paul, we also found feeding flocks of the little shearwater (*Puffinus assimilis*). Aside from Rockhopper penguins (*Eudyptes crestatus*), we could find no seabirds on St. Paul Island itself, though a number of "petrel nests" were located in small crevices and under rocky overhangs. Although the island was infested with both rats and hares, the absence of seabirds may be attributed to the fact that most species would have finished breeding and left the island by this date. We therefore spent little time on Amsterdam Island but instead confined our collecting efforts to the waters just offshore.

On the 75° E transect few seabirds were seen north of 31° S until we reached the latitudes of the Chagos and Maldive Islands. Here we found dark shearwaters, apparently the pale-footed shearwater (*Puffinus carneipes*), and scattered flocks of sooty terns. Occasional tropicbirds (*P. lepturus*) also were seen.

Several species of seabirds known to breed on the Seychelles or Mascarene Islands were not observed in the course of the two voyages. These include the Trinidad petrel (*Pterodroma arminjoniana*), red-tailed tropicbird (*Phaëthon rubricauda*), greater frigate-bird (*Fregata minor*), red-footed booby (*Sula sula*), lesser noddy (*Anous tenuirostris*), and roseate tern (*Sterna dougallii*). All of these species were encountered during subsequent field work on these islands and will be included in other reports.

OCEANOGRAPHIC DATA.—Concurrent with my seabird observations, standard oceanographic measurements (temperature profiles, nutri-

ents, plankton abundance, and primary productivity) were being taken by other members of the *Anton Bruun*'s scientific party. These data and the methods used in their determination are presented in detail in the "Final cruise report, *Anton Bruun* cruise # 5" (Woods Hole Oceanographic Institution, March 1965), and will be summarized only briefly here. The values obtained for surface salinity (36.0–36.35°/$_{oo}$), nutrient concentrations (PO_4, .46–.49μg A/l.; NO^2–N, .35–.60μg A/l.), and primary productivity (18–44μg C/1./d)[3] in the western Arabian Sea near the Gulf of Aden and Socotra (sta. 282–287) were consistently higher than most other locations visited. Although nutrient concentrations at a few of our southernmost stations (308–310) were comparable to or higher than Arabian Sea values, primary productivity levels were much lower (6–7μg C/1./d.). Unfortunately, the results of analyses of plankton samples are not yet available. Surface water temperatures in the western Arabian Sea were several degrees lower than in the seas immediately to the south. This decrease in temperature and concomitant increase in the nutrient concentrations and productivity are indicative of strong local upwelling which is known to occur in that region and which is believed to be the major determinant of the composition and density of the seabird community there (Bourne, 1963; Bailey, 1966). Between the Arabian Sea and the Mascarene Islands on the 55° E transect, surface temperatures ranged from 26° to 29.2° C. At comparable latitudes on the 75° E transect they ranged from 27° to 30.1° C. A progressive decrease in temperature was noted south of the Mascarenes, but the drop (from 19° to 15° C) was especially pronounced from 35° to 40° S, the region of the subtropical convergence. It was also in this region that the numbers of seabirds increased markedly.

Species Accounts

Eudyptes crestatus **Rockhopper Penguin**

Common at St. Paul Island on Apr. 7, where they were breeding in colonies on the steep grassy slopes though they were not nearly as abundant as Jeannel found them on these same slopes in February 1939 (Jeannel, 1941, pl. x). Many full-size young, which had lost most of the down tips on their juvenal feathers, were present, but no small young or eggs were found. The soft part colors recorded from five specimens were as follows: irides orange; bill dull orange; feet dark grey below, white above. Weights ranged from 1915 to 2475 grams (mean 2205 grams). The measurements (in mm)[4] of

[3] Average of combined values to depths of 25 percent incident light.

[4] Made by George E. Watson, Division of Birds, U.S. National Museum, Washington, D.C.

two female specimens are as follows: wing 158,162; tail molting; crest 70, 72; culmen 46.5; bill from gape 56, 57; width of bill 13.5, 14; depth of maxilla 11; foot from heel 105, 110; middle toe and claw 70, 75.

Diomedea exulans **Wandering Albatross**

One of the most common and conspicuous species in subantarctic waters below 33°52′ S on Mar. 8–9 and Apr. 3–10, 1964, its numbers reaching a maximum (25) at our southernmost station (see table 2).

Six specimens were taken, two at sea at 40°04′ S on Apr. 4 and four just off the coast of Amsterdam Island three days later. The weights of these specimens ranged from 14 to over 20 pounds. The soft part colors, including those of a brown-bodied immature were as follows: feet bluish grey to bluish white; irides brown; orbital ring light blue; bill flesh color. The gonads of these specimens were not enlarged.

On several occasions I observed a pair of birds that were sitting on the water engage in a ceremony in which one bird with its wings raised slightly over its back was fed regurgitated morsels by the other. The ceremony terminated when the receiving partner spread its wings fully, stretched its neck, pointing its bill upward, and uttered a high-pitched squealing note. It then relaxed its position. On several other occasions two birds nibbled simultaneously at the end of each other's bill without the exchange of any food or use of vocalizations. Murphy (1936, p. 558) describes similar courtship-like activities being engaged in at sea often by large groups of albatrosses.

Diomedea melanophris **Black-browed Albatross**

We observed this small mollymauk only occasionally in subantarctic waters, primarily below 40° S on Apr. 4–6 (see table 2). A single individual was present at 36°58′ S on Apr. 9.

Diomedea cauta **Shy or White-capped Albatross**

Only occasional individuals were noted in subantarctic waters south of 36°58′ S on Apr. 3–9 (see table 2).

Diomedea chlororhynchos **Yellow-nosed Albatross**

We observed this mollymauk only occasionally between latitudes 34° S and 40° S on Apr. 3–10 (see table 2).

Two specimens collected off the coast of Amsterdam Island on Apr. 8 had the following soft part colors: bill black with yellow culminocorn becoming reddish toward the tip; irides brown; feet pink. They weighed 2370 grams (male) and 2395 grams (female) and both had small gonads. The female specimen, prepared as a study skin,

measured (in mm): wing 436; tail 191; culmen 114; tarsus 75; middle toe 109. The stomach of this specimen contained the remains of a fish and a sponge.

Phoebetria fusca **Sooty Albatross**

Common in subantarctic waters below 34°32′ S on Apr. 3–10, being most abundant near Amsterdam and St. Paul Islands on Apr. 7–8 (see table 2). Many buff-headed immatures were seen.

Twelve specimens were obtained, five at sea at 40°04′ S, 75°00′ E, on Apr. 4 and seven off the coast of Amsterdam Island on Apr. 8. The soft part colors of these specimens were recorded as follows: irides brown; feet flesh-color; bill black with yellowish stripe (dull white in immatures) on lower mandible. The weights (in grams) of seven specimens were as follows: 3 males 2600, 2650, 2545; 3 females 2930, 2390, 2370; immature (sex unknown) 2440. The gonads of adults were slightly enlarged, ovaries averaging 19 x 9 mm, testes 11 x 6 mm. Three skinned specimens, two adult males and an immature, measured (in mm): wing 496, 496, 483; tail 243, 266, 245; culmen 116, 113, 106; tarsus 87, 84, 82. Of seven stomachs examined, three contained fish remains, two contained large cephalopod beaks, one contained 13 cephalopod beaks, several large shrimp, and the remains of a fish, and one stomach was empty.

Phoebetria palpebrata **Light-mantled Sooty Albatross**

One dark albatross with a light back seen at 43°31′ S, 75°27′ E, on Apr. 6 may have been this species.

Macronectes giganteus **Giant Petrel**

Only two individuals, both dark phase, were seen, one at 42°23′ S, 74°56′ E, on Apr. 5 and the other just off the coast of Amsterdam Island on Apr. 8.

Daption capense **Cape Pigeon**

I saw only one Cape pigeon briefly at 34°53′ S, 69°37′ E, on Apr. 2.

***Pachyptila* species** **Prion**

Prions, of undetermined species, were fairly common in the waters near St. Paul Island on Apr. 7 and south to 43°31′ S on Apr. 4 to 7 (see table 3).

A single *Pachyptila desolata* came aboard the *Anton Bruun* on Apr. 8 when we were about 20 miles west of Amsterdam Island. It was a female with a small ovary and weighed 121.6 grams. The bill and feet were light blue, the irides brown. It measured as follows (in mm): wing 187; tail 96; culmen 26; width bill at base 13; tarsus 34; middle toe 34. The stomach contained several small white pebbles, very likely floating pumice.

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Adamastor cinereus **Pediunker**

We saw only two, possibly three, individuals in subantarctic waters (see table 3).

Procellaria aequinoctialis **White-chinned Petrel**

White-chinned petrels were common south of the subtropical convergence where they frequently followed our ship. Our northernmost record was of a single individual at 30°50′ S, 55°09′ E, on Mar. 7. Maximum numbers were encountered at 40°04′ S, 75°00′ E, on Apr. 4 and off the coast of Amsterdam Island on Apr. 8 (see table 3).

Twelve specimens were obtained, primarily off the coast of Amsterdam Island. The soft part colors noted were: feet black; irides brown; bill light grey green with black markings. The ovaries of ten females varied in size from 7 x 4 to 15 x 8 mm; testes of two males measured 7 x 5 and 8 x 5 mm. Of nine stomachs examined, three contained cephalopods; two contained fish; two contained both fish and cephalopods; one contained pieces of fish and bologna, the latter presumably from discarded galley refuse; and one was empty.

Although I never saw this species hover like a kestrel (Watson, Zusi, and Storer, 1963), it often stops short in midair and flutters to the surface of the water. Then, preceding diving, the petrel submerges its head as if looking about under water. When it finally dives, the wings are held partially outstretched and may, therefore, be used for underwater propulsion.

Puffinus carneipes **Pale-footed Shearwater**

This dark shearwater can usually be distinguished by its large size, pale bill, and, from *P. pacificus*, by its short rounded tail. At a distance its large size and heavy flight are diagnostic. Many of the shearwaters seen near the Maldive Islands and west coast of India in late April (see table 4) were identified as this species as were four shearwaters seen on May 21 in the Arabian Sea. At least one of the birds seen near the Maldive Islands was molting its remiges.

Puffinus pacificus **Wedge-tailed Shearwater**

Only one wedge-tailed shearwater was identified positively in the Arabian Sea, on May 17 at 17°29′ N (see table 5). Some of the other dark petrels also may have been this species, but I was unable to separate them from *Bulweria fallax*, which is very similar in appearance. Several wedge-tailed shearwaters were seen as we approached the Seychelles in February, and they were numerous in this region in early June. It was common near Mauritius in February and March, and a few were seen near Reunion. Large dark shearwaters were encountered in the vicinity of the Maldive Islands in April,

but most of these seemed to be *P. carneipes;* however, 40 shearwaters seen resting on the water on Apr. 20 were identified as this species.

Puffinus griseus **Sooty Shearwater**

In early April south of the subtropical convergence we encountered several dark brown shearwaters with whitish underwings, short rounded tails, and flutter-and-glide flight. They were most common near Amsterdam Island (5–6 total) but single birds also were seen at 38°01′ S, 79°19′ E, at 40°04′ S, 75°00′ E, and near St. Paul Island. I have identified tentatively these shearwaters as *P. griseus* rather than *P. tenuirostris* on the basis of the whitish as opposed to grayish underwing coloration. Neither of these species occurs regularly in the Indian Ocean though it seems likely that *P. griseus* could stray northward from the Antarctic regions, where it is abundant during migration (Oordt and Kruijt, 1953).

Puffinus assimilis **Little Shearwater**

A single small, black and white shearwater with flutter-and-glide flight was seen at 33°52′ S, 55°05′ E, on Mar. 8. Large numbers (250+) of *P. assimilis* were found in the waters close to St. Paul Island.

Three specimens with slightly enlarged gonads were taken from the flocks feeding just off the coast of St. Paul Island on Apr. 7, 1964. The soft part colors were as follows: bill light greyish blue; feet bright blue with pink webs and some blackish on the underside; irides brown with bluish outer ring. The weights (in grams) and measurements (in mm) are included in the table below:

specimen	*sex*	*weight*	*culmen*	*wing (chord)*	*tail*	*tarsus*
GI-279	M	289	25	184	68	38
GI-280	?	263.5	25	184	68	38
GI-281	M	250.5	24.6	183	67.5	40.3

The two stomachs examined both contained the remains of many tiny cephalopods.

Conspicuous white edgings were present on the terminal portions of the dark grey feathers of the upperparts and in this respect, as well as mensural characters, the specimens resemble *P.a. munda* as described by Murphy (1927). George E. Watson, who kindly compared the one skinned specimen[5] with available material, writes that it "agrees exactly with two '*munda*' collected February 16, 1926 at 49° S, 179′ W by Beck and Correia (AMNH 211648, 211652).

[5] Careful comparison of the three specimens before preservation revealed no differences in plumage pattern or coloration.

Very similar but lacking the white tipping are a *kempi* from Chatham Island, May 1892 (USNM 208603), and an *elegans* from Nightingale Island, November 1950 (AMNH 648710)." A new subspecies, *P.a. myrtae*, with distinct white feather edgings, however, has been described recently (Bourne, 1959) and it appears that immatures and fresh-plumaged adults frequently possess white feather edgings that soon wear off (Bourne, 1959; Palmer, 1962). The specimens from St. Paul fit into the complex of southern *P. assimilis* populations, but, in view of the uncertain taxonomic relationships of these shearwaters, it seems inadvisable to assign them to subspecies on the basis of the specimen material presently available.

A breeding population of *P. assimilis* has not yet been described from St. Paul Island. Jouanin and Paulian (1960) reported the species from a single subfossil tarsus and there is a recently fledged young specimen, which was collected near St. Paul Island on Jan. 26, 1956, by P. Paulian, in the collections of the Museum National D'Histoire Naturelle in Paris (Jouanin, in litt.).

Puffinus lherminieri **Audubon's Shearwater**

This small shearwater was common in the vicinity of Socotra, the Seychelles, Mauritius, and Reunion Islands, but not in the intervening seas (see table 5). A flock of 15 small black and white shearwaters (*P.l. persicus?*) was also seen near the Pakistani coast between Bombay and Karachi on May 18, 1964.

Four *P. lherminieri* came aboard the *Anton Bruun* just north of the Seychelles during the evening of Feb. 11, and were collected. These specimens, however, will be included in a more comprehensive discussion of the seabirds of the Seychelles (Gill, in prep.).

Pterodroma baraui **Barau's Petrel**

A *Pterodroma* petrel, which I was unable to identify at the time, was fairly common in the vicinity of Reunion Island on Mar. 3 and 4, 1964. Scattered individuals, apparently of the same species were seen as far south as 27°02′ S (see table 6). Subsequent observations and study of Barau's petrel on Reunion (Jouanin and Gill, MS) convinced me that I had been seeing this recently described species.

Description (from at-sea observations): upperparts light brown, primaries darker; underparts white including the undersurface of the wing, except for a narrow black band on the fore-edge of the wing becoming widest in the primaries; face white; whitish collar; tail rounded; flight with pronounced soaring and swooping, rising high on the upswing, no flapping. Especially confusing was the fact that the back appeared brown, not the characteristic grey of *P. baraui* in the hand, but this undoubtedly resulted from the phenomenon whereby

grey or blackish birds at sea often appear brown against the blue of the ocean.

Pterodroma macroptera **Great-winged Petrel**

Occasional individuals were seen in subantarctic waters, primarily south of Amsterdam Island (see table 3). Two dark, fast-flying petrels seen at 27°02′ S, 55°49′ E, on Mar. 12 may have been this species though the proximity of the location to Reunion Island also suggests the possibility of *P. aterrima*.

Pterodroma incerta **Schlegel's Petrel**

Three individuals seen at 34°34′ S, 69°03′ E, on Apr. 2 constitute my only records of this species. Their flight consisted primarily of low gliding over the water with only occasional flapping or swooping.

Pterodroma m. mollis **Soft-plumaged Petrel**

We saw this petrel commonly in subantarctic waters south of 31°31′ S and recorded the highest numbers (30) at our southernmost station (see table 3). A petrel seen at 28°58′ S, 55°08′ E, on Mar. 6 was probably this species.

A single specimen was obtained at 40°04′ S, 75°00′ E, on Apr. 4. It was a male with small gonads and weighed 277.4 grams. The bill was black, the irides brown, and the feet were flesh colored, except for the outer toe and distal two-thirds of the web, which were black. The stomach contained cephalopod beaks. The measurements (in mm) were: wing 256.5; tail 115; culmen 28; tarsus 36; middle toe 45.

Pterodroma mollis is recognized easily by its small size, greyish-brown upperparts, and dark chest band against the white underparts. Its flight is fast and erratic with rapid swooping and swift, deep wing strokes, reminding one of a small jaeger (*Stercorarius*). Frequently it flies very high and then dives to the surface of the ocean, appearing to make "passes" at other birds. After dark (2100 hours) on Apr. 5, I saw a soft-plumaged petrel (made visible by the deck lights) feeding; it landed briefly on the water several times, picked up something from the surface, and then flew a short distance before repeating this procedure.

Pterodroma (leucoptera)

I saw a single, small, grey, black and white petrel on Mar. 13 at 24°10′ S, 56°24′ E. Apparently it was a member of the South Pacific *Cookilaria* complex though the possibility of *P. hypoleuca* could not be eliminated with certainty. Patrick J. Gould, who is familiar

with the Pacific gadfly petrels at sea, concurs in this identification after examining my field notes and sketches.

***Pterodroma* species**

An unidentified large, greyish-brown (=grey?) petrel with a darker head and tail and white underparts was observed west of the Seychelles Islands at 05°23′ S, 48°08′ E, on June 1. There was a pronounced dark stripe on the upper wing surface and the underwings were white with broad black margins. The flight consisted entirely of pendulum-like swooping motions with no flapping.

Bulweria fallax **Jouanin's Petrel**

In January and February medium-sized, all-dark petrels were seen regularly over most of the Arabian Sea between Bombay and Socotra. The majority of these could not be identified positively because of the difficulties involved in the separation of this species from *Puffinus pacificus* and perhaps some *Pterodroma* petrels; however, a few positive identifications of *B. fallax* were obtained and all individuals seen at close range proved to be this species; consequently, I have included here all unidentified dark brown petrels seen in the Arabian Sea from the *Anton Bruun*. Positive identifications are indicated in table 7 by an asterisk.

Using these criteria, 104 "*Bulweria fallax*" were seen during 64 hours of intensive surveillance between Jan. 27 and Feb. 10. Several small flocks (up to 50 birds) were encountered near Socotra, where the species was most common. My southernmost record was of four individuals at 00°31′ S, 54°56′ E, on Feb. 10.

In late May, Jouanin's petrel was the most commonly observed pelagic species on a course paralleling the Arabian coast. At least 53 *B. fallax* plus an additional 16 petrels that were either this species or *Puffinus pacificus* were seen between 22°59′ N, 65°42′ E, and 02°02′ N, 51°11′ E, in 17 hours of observation.

The flight of *B. fallax* consists of five or six quick flaps followed by a glide low over the water or a swoop down to the water from the extra height it has gained. Only occasionally does the petrel swoop in the pendulum fashion of some *Pterodroma* and, when it does, its flight hardly seems fast or erratic. The shearwater-like flight pattern seems to be used when the bird is foraging and the pendulum motion when it is travelling, though the force of the wind is also an important factor (see Bailey, 1966, p. 240). Although I saw groups of this petrel near Socotra, single individuals usually were encountered. On occasion they were seen to land on the water for extended periods of time and appeared to be feeding on squid.

Oceanites oceanicus **Wilson's Petrel**

Five scattered individuals were seen south of the subtropical convergence in early April (see table 8). None were seen in the Arabian Sea in January and February, but in May a flock of more than 50 Wilson's petrels was passed between Bombay and Karachi and still others were found near the African coast during the last week of May.

Pelagodroma marina **Frigate Petrel**

Nine frigate petrels were seen in late May between Karachi and the Seychelles Islands (see table 8). Instead of the characteristic grey, they appeared "light brown" to my eye.

Fregetta grallaria **White-bellied Storm Petrel**

Several dark storm petrels with white rumps and bellies were seen near Amsterdam and St. Paul Islands and in the waters to the south (see table 8). Although I had excellent looks at some of these, I was unable to discern any black in the middle of the white underparts. An additional 10 *Fregetta* species (probably *F. tropica:* see Bailey, 1966, p. 243) were seen in the Arabian Sea (and vicinity) between May 22 and June 2.

Oceanodroma monorhis **Swinhoe's Storm Petrel**

On two occasions (00°58′ N, 55°00′ E, on Feb. 9; 10°46′ S, 55°00′ E, on Feb. 18), I saw an all-dark storm petrel with a forked tail and very fast, erratic flight. Bailey (1965) found two species of all-dark storm petrels, the smaller of which was *O. monorhis*, verified by the capture of specimens. It seems reasonable, therefore, to assign my two observations to this species.

Oceanodroma matsudairae **Matsudaira's Storm Petrel**

Scattered individuals (12 total) of an unidentified storm petrel were seen between latitudes 07°17′ N and 21°00′ S; over one-half of these observations were made near the equator (see table 9). This petrel was the size of a large *Oceanodroma* (or *Bulweria bulweria*) but was not nearly as large as *B. fallax*. It was entirely dark brown in color though some individuals had conspicuously paler upper wing coverts. The flight was deliberate, almost sluggish, consisting of four or five deep wing strokes followed by a short glide with the wings bowed downward. The tail appeared either square or slightly forked.

Bailey (1964, 1965) observed a large *Oceanodroma* commonly in the vicinity of the equator from March to May 1964 and suggested that it was *O. matsudairae* from the Pacific. Since then, two specimens confirming this tentative identification have been collected in the

Indian Ocean off Western Australia by Pocklington, Willis, and Palmieri (unpubl.).

Phaëthon aethereus **Red-billed Tropicbird**

In late January and early February this tropicbird was fairly common in the western Arabian Sea east to 69°11′ E and south to 11°01′ N, often very far from land (see table 10). In late May, five were seen only 17°29′ N, 62°31′ E, and three at 02°02′ N, 51°11′ E. No other species of tropicbirds were identified in this region.

Phaëthon lepturus **White-tailed Tropicbird**

White-tailed tropicbirds were first encountered at 08°42′ S, 55°07′ E, on Feb. 17 and were not seen south of 24° S on this transect of the cruise (see table 11). On the 75° E transect the first one was seen at 16°42′ S; we noted the species at only two of the remaining stations to the north. Many white-tailed tropicbirds were present near the the Seychelles Islands on June 2.

Sula dactylatra **Masked Booby**

Scattered individuals were seen in the southwestern Arabian Sea and near the Seychelles Islands in January–February and again in late May (see table 10).

Sula leucogaster **Brown Booby**

Four adults were seen near Socotra, one at 14°40′ N, 55°25′ E, on Feb. 1 and three at 11°30′ N, 52°53′ E, on Feb. 4.

Fregata ariel **Lesser Frigatebird**

I saw this species only twice; three at 07°02′ S, 55°11′ E, on Feb. 16, and two near the Seychelles Islands on June 2.

Lobipes lobatus **Northern Phalarope**

Ten northern phalaropes were seen near the Indian coast (17°44′ N, 69°11′ E) on Jan. 27.

Catharacta skua **Skua**

A single individual was seen five miles west of Mauritius on Mar. 2. Three skuas were observed at St. Paul Island on Apr. 7.

Larus fuscus **Lesser Black-backed Gull**

Several were seen near the Gulf of Aden, one on Feb. 2 and five on Feb. 3.

Larus hemprichii **Aden Gull**

Two, possibly three, individuals were seen in the Gulf of Aden on Feb. 1–2.

Larus brunneicephalus **Indian Black-headed Gull**

A flock of 12 was passed about 75 miles east southeast of Bombay on Jan. 27.

Sterna vittata tristanensis **Murphy** **Antarctic Tern**

This tern was common near both St. Paul and Amsterdam Islands, where flocks of up to 100 individuals were seen just offshore.

Thirteen specimens in molt and nonbreeding condition were collected, one at St. Paul Island on Apr. 7 and the rest at Amsterdam Island on Apr. 8. In addition to winter-plumaged adults, they include several heavily barred immatures. Measurements of the skins from Amsterdam Island are included in table 12. Although the wings of this series are small (cf. Murphy, 1938), the culmen and tarsus lengths seem sufficient to separate this race from the smaller *S. v. vittata*, which breeds on Kerguelen. Of 10 stomachs examined, four contained tiny cephalopods, four contained fish, one had both fish and cephalopods, and one contained the remains of small crustacea.

Sterna repressa **White-cheeked Tern**

Common at sea between Bombay and Karachi on May 18.

Sterna anaethetus **Bridled Tern**

Seen at sea only in the vicinity of the Seychelles Islands on June 2.

Sterna fuscata **Sooty Tern**

Although sooty terns were absent from the Arabian Sea south to the Seychelles in January and February, large flocks were seen 200–300 miles east of the Somalian coast of East Africa (between 06°46′ N, 55°00′ E, and 06°05′ S, 42°11′ E) and east to the Seychelles Islands in late May (see table 11). Sooty terns were common near Mauritius in February and March, and scattered individuals and flocks were seen near the Chagos and Maldive Islands in late April.

Thalasseus bergii **Crested Tern**

Five *Thalasseus* terns were seen at 06°05′ S, 42°11′ E, on May 31 and a single *T. bergii* was observed near the Seychelles on June 2.

Anous stolidus **Common Noddy**

Common noddies were numerous near both the Seychelles Islands and Mauritius, but only two individuals were seen at sea, one at 00°27′ S, 54°57′ E, on Feb. 10 and the other at 22°51′ S, 54°58′ E (southwest of Reunion), on Mar. 4.

Gygis alba **Fairy Tern**

Fairy terns were seen close to the Seychelles Islands in both February and June.

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In early February between 08°00′ N and 00°49′ S on the 55° E transect, a species of tern was noted flying around the *Anton Bruun* at night (see table 13). Using spot lights, we obtained good observations, discerning an *all*-white tern with a slightly forked tail that left, in my opinion, little doubt as to the identity. The birds were quite vocal, emitting short, low notes, especially when two were together. The presence of fairy terns so far out to sea and only at night (none were seen during the daytime watches) is surprising, for the nearest possible source of these birds, the Seychelles Islands, was well over 600 miles to the south and *Gygis* is usually known as a coastal or inshore species, not a pelagic one (Murphy, 1936). One wonders, however, whether scattered individuals were drawn to and concentrated around the ship at night, thereby becoming conspicuous, and also whether the species might not be as highly nocturnal as the huge eyes and pure white plumage suggest. These observations should remain hypothetical pending future confirmation.

Discussion

The distribution of seabird species and numbers is related to oceanographic factors that produce a suitable variety and abundance of food items (Jespersen, 1929; Hutchinson, 1950; Murphy, 1936). Although the data presented in this paper are insufficient in themselves, it is hoped that the total information gathered during the International Indian Ocean Expedition eventually will provide the basis for a detailed analysis of the factors underlying seabird distributional patterns in the Indian Ocean. A noteworthy step in this direction has been made recently by Bailey (1966) for the important region of upwelling off the southern Arabian coast. The rest of the Indian Ocean, however, awaits comparable attention.

One of the conclusions that is readily apparent from the data presented in this paper is the paucity of seabirds in the major part of the western Indian Ocean. In this respect, the Indian Ocean is similar to other tropical oceans, which are characterized by the relative infertility of their waters and a consequent scarcity of seabirds, except in the vicinity of land, either islands or continental coasts, and regions of local enrichment. It was only in the western Arabian Sea and below the subtropical convergence, regions where upwelling, cooler surface temperatures or other factors permit nutrient replenishment and continued productivity, and near the Seychelles and Mascarene Islands, which provide land necessary for breeding and roosting, that seabirds were at all numerous. But even the maximum numbers (200+/hour) I recorded in these regions were certainly small compared to what is possible in other parts of the world ocean (see Murphy, 1914; Oordt and Kruijt, 1955), especially

at higher latitudes. The numbers of seabirds recorded by Bailey (1966) off Arabia were also considerably greater than my counts and serve to emphasize the highly localized nature of seabird distribution in the Indian Ocean.

The composition of seabird communities often changes markedly during a year because of movements of seabirds that correspond to changes in the availability of food items and/or that are a part of extensive postbreeding migrations. In the Indian Ocean the most striking seasonal differences are those found in the western Arabian Sea (see Bailey, 1966; Bourne, 1960, 1963; Jouanin, 1957). In this area there is, first of all, a resident seabird community, which includes no less than eight endemic forms (four species and four subspecies). The majority of its species occur primarily in the inshore waters close to breeding and/or roosting stations (Bailey, 1966) with the result that only a few, e.g., *Bulweria fallax* and *Phaëthon aethereus*, are encountered regularly as far out to sea as were the stations included in this report. The presence of dark petrels, all apparently *B. fallax*, at our stations in the Arabian Sea in January and February east as far as 69°11′ E suggests that Jouanin's petrel disperses widely at sea from its yet undiscovered breeding stations near the Arabian coast, at least during the nonbreeding season. Unfortunately, the southern limits of these movements remain uncertain because of the difficulty of separating it from other dark petrels. All my records were made north of the equator (actually 00°31′ S), but there is a specimen from Kenya (Jouanin, 1957), and Bailey (in prep.) saw dark petrels "inseparable from *B. fallax* south to 15° S."

In May, coinciding with the onset of the monsoon winds, with the consequent offshore upwelling, and with increased productivity, the resident species of the western Arabian Sea are subjected to an influx of large numbers of several migrant species from the subantarctic Indian Ocean. Included in this arriving assemblage are three species of storm petrels: *Oceanites oceanicus* and *Fregetta tropica* from Kerguelen and the Crozet Islands (Bourne, 1960), and *Pelagodroma marina* from breeding stations off southwest Australia (Mörzer Bruyns and Voous, 1964). All of my observations are in accord with the known arrival times and distribution of these species in the northern Indian Ocean, though actual records of Wilson's petrels near the African coast may be noteworthy.

Arriving from the same area as *Pelagodroma* is the large pale-footed shearwater, *Puffinus carneipes*. Unfortunately, the majority of shearwaters I saw near the Maldive Islands in April did not come close enough to permit positive identification; however, most appeared too large, with too heavy a flight to be *P. pacificus* and consequently were considered to be *P. carneipes*. A light bill could be discerned on a

few individuals. Although large numbers do not appear until late May, pale-footed shearwaters are known to arrive in the Arabian Sea as early as mid-April (see Bailey, 1966) and, hence, records near the Maldives would not be unexpected at this time.

The status of the other dark shearwater in the Arabian Sea, the wedge-tailed shearwater, is particularly hazy because of the ease of confusion with *Bulweria fallax*. For years it was considered to be the common dark petrel in the western Arabian Sea (Alexander, 1931; Phillips, 1954) until these records were reexamined (Jouanin, 1957) in light of the discovery of *B. fallax*, which is very similar in appearance. Although a few specimens have been taken in the Arabian Sea, wedge-tailed shearwaters certainly appear to be rare there, for Bailey (1966) recorded none positively north of 10° N and I saw but one. It seems necessary, therefore, to establish just how common this species actually is in order to determine whether only occasional stragglers are involved or whether there are enough to justify postulations of either a local population or a migratory movement from another part of the Indian Ocean. The latter possibilities have been suggested (Bourne, 1960), and the idea of a local undiscovered breeding population seems especially attractive in view of several recent discoveries of small breeding populations of this species on tiny rock offshore islets, for example near Madagascar (Appert, 1965), Reunion (Jouanin, pers. comm.) and Roderigues (Vinson, 1965). In this connection also, the Maldive Islands may harbor a population of wedge-tailed shearwaters, thereby accounting for some of the shearwaters seen at sea in that area.

Just now being established is the regular occurrence in the equatorial regions of the Indian Ocean of two storm petrels from the Pacific, *Oceanodroma monorhis* and *O. matsudairae*. Although their numbers seem to be greatest during the northern summer (Bailey, in prep.), my observations indicate that at least small numbers are present throughout the year. One cannot help but wonder if there are also undiscovered breeding populations of storm petrels in the Indian Ocean, and again the Maldive or perhaps the Chagos Islands seem likely locations. In addition to *Oceanodroma* species, *Bulweria bulweria*, which has been recorded in the Indian Ocean (Phillips, 1959; Bourne, 1960; Jouanin, 1957), might also be sought.

Perhaps the least understood seasonal change in the western Indian Ocean are the movements of the sooty terns that breed in the Seychelles and Amirante Islands in huge numbers from May to October and that then disappear for the remainder of the year. Whether they move to other island groups, such as the Aldabras, Chagos, or perhaps Cargados Carajos Shoals, or spend these six months at sea is unknown. In February I saw no sooty terns north

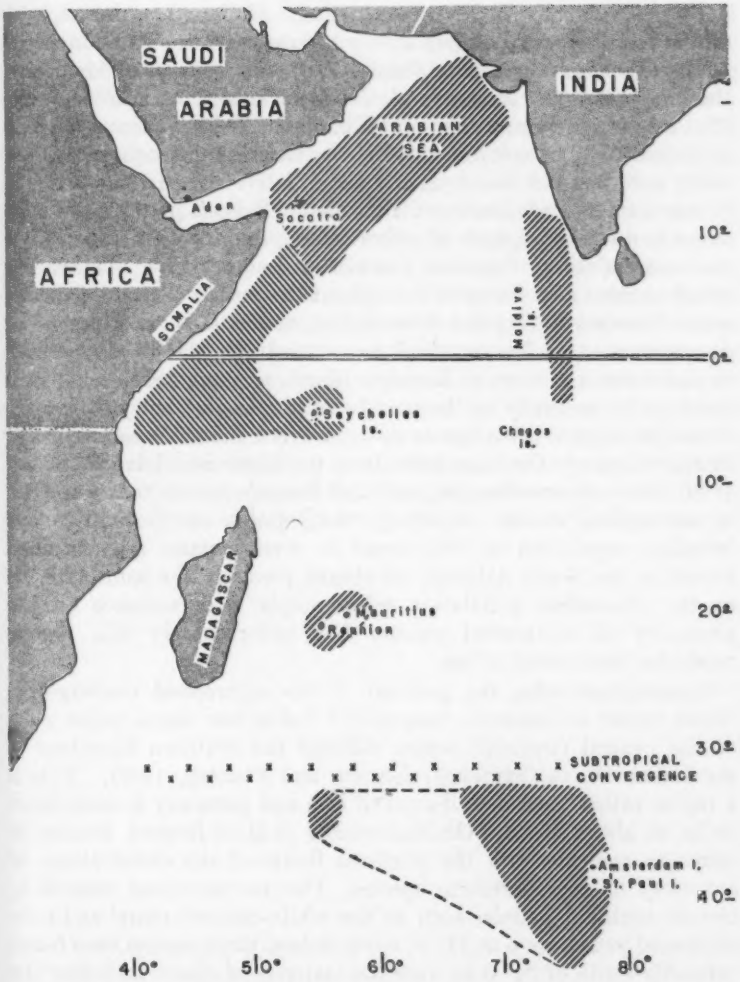

FIGURE 2.—Regions of observed seabird abundance in the western Indian Ocean.

of the Mascarene Islands on our 55° E transect, whereas in May large flocks were present at 06°46′ N on this same longitude, as well as the seas south to the Seychelles and southwest to the African coast. Other observers (e.g., Bailey, in prep.) report a similar seasonality in their observations of sooty terns in this region.

The Mascarene region is of particular interest because it is the only place in the tropical or subtropical Indian Ocean where breeding

petrels of the genus *Pterodroma* are found. No less than three species of *Pterodroma* breed (or did) in the Mascarenes: the Trinidad petrel (*P. arminjoniana*) on Round Island off the north coast of Mauritius; Barau's petrel (*P. barau*i) and the little known Mascarene petrel (*P. aterrima*), presumably on Reunion. This latter species is apparently extinct as it has not been seen alive in this century (Bourne, 1965) and was not found during an intensive search for petrels on Reunion in 1964 (Jouanin and Gill, MS). Barau's petrel is the most recently described species of petrel (1964), despite its being a fairly common species on Reunion; however, it is not known whether this petrel remains near Reunion throughout the year or disperses to sea in some direction during the nonbreeding season (austral winter). It does appear to confine its pelagic activities during the breeding season to the south and west of Reunion Island, as none were seen to the north or immediately to the east by either Roger Bailey or myself. Since the tropical convergence in the western Indian Ocean is located at approximately the same latitude as the Mascarene Islands (Baker, 1965), these observations suggest that Barau's petrel feeds primarily in subtropical waters. Similarly, the location of the only other breeding population of *Pterodroma a. arminjoniana* (on Trinidad Island in the South Atlantic) at almost precisely the same latitude as the Mascarene population might imply a dependence on the proximity of subtropical waters, but unfortunately this species rarely has been noted at sea.

Oceanographically, the position of the subtropical convergence, where cooler subantarctic waters sink below the warm water mass of the central (tropical) ocean, delimits the southern boundary of the Indian Ocean (Sverdrup, Johnson and Fleming, 1942). This is a *region* rather than a well-marked line and generally is considered to lie at about 40° S. Ornithologically it is of interest because it seems to coincide with the northern limits of the distributions of a variety of procellariiform species. Our northernmost records of certain southern petrels, such as the white-chinned petrel and soft-plumaged petrel, were at 31° S; nevertheless, these species were found primarily south of 34° S as were the majority of others including the albatrosses. On a transect in early July, comparable to our 55° E transect, Rand (1962) also encountered the first southern petrels at about 30° S and noted a marked increase just below 35° S; however, the numbers of individuals and the variety of species he recorded were slightly greater than ours and, in addition, he found them as far north as 26° S at stations closer to the African coast. The surface water temperatures recorded by Rand averaged several degrees lower than our measurements.

Although many of the species encountered by Rand below 30° S were the same as we found, there were several important differences. Conspicuous by their absence on our March–April cruise were Cape pigeons (*Daption capense*) which were the "most abundant of small petrels" on his cruise in June–July. Also, on a previous cruise of the *Anton Bruun* through these latitudes in September (1963) Cape pigeons were common (P. Willis, pers. comm.). On the other hand, Rand saw few white-chinned petrels (*Procellaria aequinoctialis*) except near the African coast, whereas in March and April this was a predominant species at our southern stations. Similarly, the soft-plumaged petrel (*Pterodroma mollis*), which was a common species at our stations, was not even recorded by Rand. It is unfortunate that so few detailed reports of seabird species and numbers are available for this region as there seem to be marked seasonal fluctuations in the composition, distribution, and perhaps size of its seabird community. Some of these may be related only to reduced pelagic activity during the breeding season but others may be correlated with seasonal changes in productivity. Also interesting would be an elucidation of the subtropical convergence's role in limiting seabird distribution.

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TABLE 1.—*Seabird numbers recorded during standardized watch periods* (station = IIOE Oceanographic Station, *Anton Bruun;* A = Procellariiformes; B = Pelecaniformes; C = Charadriiformes)

Date	Locality	Sta. No.	Water temp. (° C)	Time	A	B	C	Birds/ Hr.
Jan. 27	17°44′ N, 69°11′ E	–	–	0900–1100	6	4	22	16
" 28	17 12 N, 67 00 E	–	–	0755–1045	6	2	0	2.5
" 29	16 13 N, 63 29 E	282	25.2	0830–1130	2	1	0	1
" 30	15 42 N, 60 52 E	283	25.1	0830–1100	2	2	0	1.6
" 31	15 22 N, 58 12 E	284	23.9	0830–1130	3	1	0	1.3
" 31	15 18 N, 57 59 E	–	–	1530–1630	12	1	0	13
Feb. 1	14 22 N, 55 18 E	285	24.0	0800–1100	4	0	0	1.3
" 2	13 50 N, 52 59 E	286	24.9	0815–1115	4	3	1	2.6
" 3	13 11 N, 50 22 E	287	24.8	0805–1105	0	0	6	2
" 3	13 08 N, 50 36 E	–	–	1600–1700	9	0	0	9
" 4	11 30 N, 52 53 E	–	–	0835–1135	80+	3	0	27
" 4	11 01 N, 53 30 E	–	–	1345–1645	7	0	16	7.6
" 5	09 28 N, 54 52 E	288	26.0	0820–1120	3	0	0	1
" 6	07 10 N, 55 05 E	289	26.5	0815–1045	4	0	0	1.3
" 6	06 52 N, 55 06 E	–	–	1730–1830	2	0	0	2
" 7	05 02 N, 55 01 E	290	26.5	0800–1100	0	0	0	0
" 8	02 31 N, 55 04 E	291	27.6	0810–1110	0	0	0	0
" 8	02 15 N, 54 57 E	–	–	1720–1820	1	0	0	1
" 9	01 03 N, 54 56 E	292	28.0	0820–1120	1	0	0	0.3
" 9	00 58 N, 54 53 E	–	–	1720–1820	2	0	0	2
" 10	00 31 S, 54 56 E	293	28.2	0820–1120	6	0	1	2.3
" 10	00 49 S, 54 49 E	–	–	1720–1820	2	0	0	2
" 11	02 51 S, 54 58 E	294	28.3	0830–1130	5	0	0	1.6
" 11	03 20 S, 55 13 E	–	–	1725–1825	6	0	6	12
" 15	Seychelles, east coast of Mahé	–	–	1730–1830	11	0	2	13
" 16	06 28 S, 55 12 E	295	29.2	0810–1110	1	0	0	0.3
" 17	08 42 S, 55 07 E	296	28.4	0800–1120	2	2	0	1.3
" 17	09 02 S, 55 13 E	–	–	1720–1820	0	0	0	0
" 18	10 47 S, 55 15 E	297	28.9	0800–1100	3	0	0	1
" 19	12 33 S, 54 33 E	298	28.4	0840–1140	1	1	0	0.6
" 19	13 04 S, 54 37 E	–	–	1720–1820	0	0	0	0
" 20	14 57 S, 54 43 E	299	27.6	0810–1050	0	1	0	0.3
" 20	15 34 S, 54 50 E	–	–	1720–1820	0	0	0	0
" 21	17 14 S, 54 38 E	300	28.0	0815–1115	–	1	0	0.3
" 22	Mauritius (50 to 20 miles west)	–	–	0900–1130	40	5	170	86
Mar. 2	Mauritius (0 to 30 miles west)	–	–	1430–1630	12	2	15	14.5
" 3	19 57 S, 54 58 E	301	26.8	0810–1110	4	5	4	4.3
" 3	20 34 S, 54 58 E	–	–	1745–1830	6	2	0	10.6
" 4	23 07 S, 54 50 E	302	25.8	0805–1105	9	0	1	3.3
" 4	24 07 S, 54 55 E	–	–	1730–1830	2	0	0	2
" 5	26 00 S, 54 52 E	303	25.4	0830–1130	1	0	0	0.3
" 5	26 25 S, 55 01 E	–	–	1730–1830	1	0	0	1
" 6	28 22 S, 55 02 E	304	24.8	0815–1115	0	0	0	0
" 6	28 58 S, 55 08 E	–	–	1720–1820	0	0	0	0
" 7	30 50 S, 55 09 E	305	22.4	0820–1120	1	0	0	0.3
" 7	31 25 S, 54 59 E	–	–	1720–1820	0	0	0	0
" 8	33 13 S, 55 10 E	306	21.0	0805–1125	67	0	0	2
" 8	33 52 S, 55 05 E	–	–	1730–1845	4	0	0	3.2
" 9	35 42 S, 55 15 E	307	19.7	0800–1100	11	0	0	3.6
" 9	35 00 S, 55 16 E	–	–	1725–1825	5	0	0	5
" 12	27 02 S, 55 49 E	–	–	1730–1830	1	0	0	1
" 13	24 10 S, 56 24 E	–	–	0825–1025	1	0	0	0.5

TABLE 1.—Continued

Date	Locality	Sta. No.	Water temp. (° C)	Time	A	B	C	Birds/ Hr.
Mar. 14	21°00′ S, 57°00′ E	–	–	0830-1130	4	1	145	50
" 14	20 40 S, 57 07 E	–	–	1220-1420	300	1	100	200
" 29	21 43 S, 57 43 E	–	–	0825-0925	0	0	1	1
" 29	22 33 S, 58 22 E	–	–	1420-1620	3	0	5	4
" 30	24 57 S, 60 09 E	–	–	0835-1035	0	0	0	0
" 31	28 44 S, 63 36 E	–	–	1415-1615	0	0	0	0
Apr. 1	31 29 S, 65 58 E	–	–	0815-1115	0	0	0	0
" 1	32 20 S, 66 47 E	–	–	1545-1645	0	0	0	0
" 2	34 24 S, 69 03 E	–	20-19.2	0830-1130	5	0	0	1.6
" 2	34 53 S, 69 37 E	–	–	1345-1445	1	0	0	1
" 3	37 55 S, 72 23 E	–	–	0800-1100	29+	0	0	10
" 3	38 01 S, 73 19 E	–	–	1400-1700	25	0	0	8.3
" 4	40 04 S, 75 00 E	308	15.0	0600-0930	92	0	0	23.4
" 5	42 23 S, 74 54 E	309	12.1	0830-1430	37	0	0	6
" 6	43 31 S, 75 27 E	–	–	0700-1600	126	0	0	14
" 7	39 48 S, 77 20 E	–	–	0845-1100	32	0	0	14
" 7	St. Paul Island (within 30 miles)	309C	–	1200-1500	300+	0	53+	120
" 8	Amsterdam Island (offshore)	309E	–	all day	120	0	150	–
" 9	37 01 S, 75 19 E	310	17.0	0630-0930	21	0	0	7
" 10	34 31 S, 74 47 E	311	19.3	0630-0930	15	0	0	5
" 11	31 26 S, 74 57 E	312	22.6	0800-1000	2	0	0	1
" 12	29 00 S, 74 51 E	313	22.5	0630-0930	1	0	0	0.3
" 13	26 27 S, 75 02 E	314	24.5	0630-0730	0	0	0	0
" 14	24 20 S, 74 52 E	315	24.7	0800-1000	0	0	0	0
" 15	21 58 S, 74 55 E	316	26.0	0830-1030	0	0	1	0.5
" 16	19 44 S, 75 20 E	317	27.0	0800-1000	0	0	0	0
" 17	16 43 S, 74 53 E	318	28.1	0825-1025	0	1	0	0.5
" 18	14 10 S, 74 55 E	319	28.3	0830-1030	1?	0	0	0.5
" 19	11 47 S, 74 42 E	320	28.8	0820-1020	0	0	0	0
" 20	09 21 S, 75 08 E	321	29.3	0810-1010	0	0	0	0
" 21	06 50 S, 75 02 E	322	29.2	0820-1020	0	0	0	0
" 22	04 11 S, 75 00 E	323	29.1	0820-1020	1	0	0	0.5
" 24-27	Maldive Islands (Addu Atoll)	–	–	no standardized watch	–	–	–	–
" 28-30	Maldives to Cochin, India	325-327	–	no standardized watches	–	–	–	–
May 18	Bombay to Karachi	–	–	0900-1300	65	0	200+	66
" 20	22 59 N, 65 42 E	–	–	0905-1105	2	0	0	1
" 21	17 29 N, 62 31 E	–	–	0915-1245	28	4	0	91
				1400-1545	11	1	0	6.8
" 22	12 05 N, 58 58 E	–	–	0910-1130	26	0	0	11.3
				1410-1530	5	0	0	3.3
" 23	06 46 N, 55 00 E	–	–	0845-0945	1	0	0	1
				1400-1600	6+	0	8+	7
" 24	02 02 N, 51 11 E	–	–	0925-1225	9	3	275	96
" 25	01 42 S, 45 46 E	–	–	0910-1110	10	0	500	255
" 26	Mombasa—32 miles northeast	–	–	0910-1010	1	0	0	1
" 31	06 05 S, 42 11 E	–	–	0915-1215	2	0	76	26
June 1	05 23 S, 48 08 E	–	–	0915-1215	2	1	360+	120
" 2	04 33 S, 54 17 E (Seychelles Is.)	–	–	0910-1210	11	2	226	80

TABLE 2.—*Observations of albatrosses (Diomedeidae)*

Date	Location	Time	*Diomedea exulans*	*Diomedea melanophris*	*Diomedea chlororhynchos*	*Diomedea cauta*	*Phoebetria fusca*
Mar. 8	33°52′ S, 55°05′ E	1730–1845	1	0	0	0	0
" 9	35 42 S, 55 15 E	0800–1100	1	0	0	0	0
Apr. 3	37 55 S, 72 23 E	0800–1100	12	0	2	1	0
" 3	38 01 S, 73 19 E	1400–1700	6	0	2	0	0
" 4	40 04 S, 75 00 E	all day	20	4–5	0	2–3	10
" 5	42 23 S, 74 54 E	all day	6	1	0	0	2–3
" 6	43 31 S, 75 27 E	all day	25	2–3	0	2–3	4–5
" 7	38 48 S, 77 20 E	0845–1100	17	0	1	2	3
" 7	St. Paul Island (within 30 miles)	1200–1500	12	0	0	0	10
" 8	Amsterdam Island (off-shore)	all day	15	0	4–5	0	25–30
" 9	37 01 S, 75 19 E	all day	6	1	0	1	1
" 10	34 31 S, 74 47 E	0630–0930	1	0	4 (repeats)	0	1

TABLE 3.—*Observations of subantarctic petrels (Procellaridae)*

Date	Location	Time	*Procellaria aequinoctialis*	*Adamastor cinereus*	*Pterodroma macroptera*	*Pterodroma mollis*	*Pachyptila* species
Mar. 7	30°50′ S, 55°09′ E	0820–1120	1	0	0	0	0
" 8	33 13 S, 55 05 E	0805–1125	8	0	0	0	0
	33 52 S, 55 05 E	1730–1845	2	0	0	0	0
" 9	35 42 S, 55 15 E	0800–1100	11	0	0	8	0
" 12	27 02 S, 55 49 E	0930	0	0	2?	0	0
Apr. 2	34 24 S, 69 03 E	0830–1130	1?	0	0	0	0
" 3	37 55 S, 72 23 E	0800–1100	10	0	0	5	0
	38 01 S, 73 19 E	1400–1700	8	0	0	4	0
" 4	40 04 S, 75 00 E	all day	30	0	1	15	5–6
" 5	42 23 S, 74 54 E	all day	10	0	1–2	3–4	20
" 6	43 31 S, 75 27 E	all day	20	1–2	6	30	30
" 7	38 48 S, 77 20 E	0845–1100	5	1	3	2	7
" 7	St. Paul Island (0–30 miles)	1200–1500	10	0	0	0	10
" 8	Amsterdam Island (offshore)	all day	40	0	4–5	4	1
" 9	37 01 S, 75 19 E	all day	7	0	0	3–4	0
" 10	34 31 S, 74 47 E	0630–0930	5	0	2?	1	0
" 11	31 26 S, 74 57 E	0800–1000	0	0	0	2	0
" 12	29 00 S, 74 51 E	0630–0930	0	0	0	1?	0

TABLE 4.—*Observations of* Puffinus carneipes

Date	Location	Time	Number	*Phoebetria fusca*
		1415		
Apr. 19	11°47′ S, 74°42′ E	0820–1020	1	0
" 22	04 11 S, 75 00 E	1200, 1800	1?	0
" 23	02 14 S, 75 14 E	0630–0730	1, 1	0
" 24	Maldive Islands (Addu Atoll, Gan Is.)		2	0
" 28	02 01 N, 75 13 E	1600	1 (reported)	0
" 29	04 49 N, 74 55 E	1400	2	10
" 30	06 51 N, 75 02 E	1030	4	2–3
May 3	14 48 N, 73 41 E	1200	8 (reported)	4–5
" 21	17 29 N, 62 31 E	0915–1245	3	3
		1400–1545	1	10

TABLE 5.—*Observations of tropical shearwaters* (Puffinus)

Date	Location	Time	*pacificus*	*lherminieri*	*Pachyptila* species
Jan. 29	16°13′ N, 63°29′ E	0830–1130	2?	0	0
Feb. 1	14 22 N, 55 18 E	0800–1100	0	4	0
	14 09 N, 54 38 E	1830	0	1	0
" 2	13 50 N, 52 59 E	0815–1115	0	3	0
	13 51 N, 52 45 E	1600–1700	0	7	0
" 3	12 55 N, 50 54 E	1830	0	1	0
" 4	11 30 N, 52 53 E	0835–1135	0	3	0
	11 01 N, 53 30 E	1345–1645	0	1	0
" 11	02 51 S, 54 58 E	0830–1130	0	1	0
	03 22 S, 55 13 E	1725–1825	5	0	0
	03 30 S, 55 19 E	2000	0	12	0
" 15	Seychelles Islands (east coast of Mahe)	1700–1800	0	11	0
" 16	06 28 S, 55 12 E	0810–1110	1	0	0
" 18	10 47 S, 55 15 E	0800–1100	2	0	0
" 22	Mauritius—50 to 20 miles west	0900–1130	38	1	5–6
Mar. 2	Mauritius—0 to 30 miles west	1430–1630	21	1	20
" 3	19 57 S, 54 58 E	0810–1110	0	1	30
	20 34 S, 54 58 E	1745–1830	1	3	7
" 14	20 40 S, 57 07 E	0830	0	2	10
	Mauritius—20 miles south southeast	1220–1420	300	0	1
Apr. 20	09 00 S, 75 00 E	1500	40?	0	0
May 18	Bombay to Karachi	1130	0	15	0
" 21	17 29 N, 62 31 E	0915–1245	1	0	0
" 22	12 05 N, 58 58 E	1410–1530	0	1	0
" 24	02 02 N, 51 11 E	0925–1225	8?	0	0
June 2	04 33 S, 54 17 E	0910–1210	2	8	? 0

TABLE 6.—*Observations of* Pterodroma baraui

Date	Location	Time	Number
Mar. 3	19°57′ S, 54°58′ E	0810–111	1
	20 35 S, 54 58 E	1745–1830	4
" 4	23 07 S, 54 50 E	0805–1105	9
	24 07 S, 54 55 E	1650, 1730–1830	1, 2
" 5	26 00 S, 54 52 E	0830–1130	1?
	26 25 S, 55 01 E	1730–1830	1?
" 12	27 02 S, 55 49 E	1730–1830	1?
" 13	23 41 S, 56 23 E	1230–1400	1?

TABLE 7.—*Observations of* Bulweria fallax

Date	Location	Time	Number
Jan. 27	17°44′ N, 69°11′ E	0900–1100	6
" 28	17 12 N, 67 00 E	0755–1045	*6
" 30	15 42 N, 60 52 E	0830–1130	2
" 31	15 22 N, 58 12 E	0830–1130	3
	15 18 N, 57 59 E	1530–1630	*12
Feb. 1	14 08 N, 54 34 E	1830	1
" 2	13 50 N, 52 59 E	0815–1115	1
	13 51 N, 52 45 E	1600–1700	2
" 4	11 30 N, 52 53 E	0835–1135	*53+
	11 01 N, 53 30 E	1345–1645	*7
" 5	09 28 N, 54 52 E	0820–1120	2
" 6	07 10 N, 55 05 E	0815–0145	4
	06 52 N, 55 06 E	1730–1830	*2
" 8	02 15 N, 54 57 E	1720–1820	1
" 9	00 58 N, 54 53 E	1720–1820	1
" 10	00 31 S, 54 56 E	0820–1120	4
May 20	22 59 N, 65 42 E	0905–1105	2
" 21	17 29 N, 62 31 E	0915–1245	*15
		1400–1545	*10
" 22	12 05 N, 58 58 E	0810–1130	*22
		1430–1530	2
" 23	06 56 N, 55 90 E	0845–0945	1
" 24	02 02 N, 51 11 E	0925–1225	1
" 25	01 42 S, 45 46 E	0910–1110	1?

*Positive identification.

TABLE 8.—*Observations of storm petrels (Hydrobatidae)*

Date	Location	Time	*Oceanites oceanicus*	*Pelagodroma marina*	*Fregetta* sp.
Apr. 2	34°24′ S, 69°03′ E	0830–1130	1	0	0
" 3	37 55 S, 72 23 E	0800–1100	1	0	0
	38 01 S, 73 19 E	1400–1600	1	0	1
" 5	42 23 S, 74 54 E	all day	1	0	0
" 6	43 31 S, 75 27 E	all day	1	0	1
" 7	39 48 S, 77 20 E	0845–1100	0	0	1
	St. Paul Island—within 30 miles	1200–1500	0	0	6
" 8	Amsterdam Island (offshore)	all day	0	0	3–4
May 18	Bombay, Karachi	1220	50+	0	0
" 21	17 29 N, 62 31 E	0910–1245	0	1	0
" 22	12 05 N, 58 58 E	0910–1130	0	4	0
		1410–1530	0	0	2
" 23	06 46 N, 55 00 E	1400–1600	0	0	5
" 25	01 42 S, 45 46 E	0910–1110	6	1	2
" 26	32 miles northeast of Mombasa	0910–1010	1	0	0
" 31	06 05 S, 42 11 E	0915–1215	0	2	0
June 1	05 23 S, 48 08 E	0915–0215	0	0	1?
" 2	04 33 S, 54 17 E	0910–1210	0	0	1

TABLE 9.—*Observations of* "Oceanodroma matsudairae"

Date	Location	Time	Number
Feb. 6	07°10′ N, 55°05′ E	0815–1945	1
" 10	00 49 S, 54 59 E	1720–1820	2
" 11	02 51 S, 54 58 E	0830–1030	4
	03 20 S, 55 13 E	1725–1825	1
" 18	10 47 S, 55 15 E	0800–1100	1
Mar. 14	21 00 S, 57 00 E	0830–1130	2
Apr. 19	11 47 S, 74 43 E	1415	1

TABLE 10.—*Observations of* Phaëthon aethereus *and* Sula dactylatra

Date	Location	Time	*Phaëthon aethereus*	*Sula dactylatra*
Jan. 27	17°44′ N, 69°11′ E	0900–1100	4	0
		1600	2	0
" 28	17 12 N, 67 00 E	0755–1045	2	0
" 29	16 14 N, 63 27 E	0800–1130	1	1
		1500–1715	2	0
" 30	15 52 N, 60 52 E	0830–1100	4	1
	15 42 N, 60 38 E	1730	2	0
" 31	15 22 N, 58 12 E	0830–1130	1	0
	15 18 N, 57 59 E	1530–1630	0	1
Feb. 2	13 50 N, 52 59 E	0815–1115	1?	1
" 4	11 01 N, 53 30 E	1725	1	0
" 17	08 42 S, 55 07 E	0800–1120	0	1
May 20	22 59 N, 65 42 E	1400	0	1
" 21	17 29 N, 62 31 E	0915–1245	4	0
		1400–1545	1	0
" 24	02 02 N, 51 11 E	0925–1225	3	0
June 1	05 23 S, 48 08 E	0925–1225	0	1

TABLE 11.—*Observations of* Phaëthon lepturus *and* Sterna fuscata

Date	Location	Time	*Phaëthon lepturus*	*Sterna fuscata*
Feb. 17	08°42′ S, 55°07′ E	0800–1120	1	0
" 21	17 14 S, 54 38 E	0815–1115	1	0
" 22	Mauritius—50 to 20 miles west	0900–1130	5	170+
Mar. 2	Mauritius—zero to 30 miles west	1430–1630	3	13
" 3	19 57 S, 54 58 E	0810–1110	5	4
	20 34 S, 54 58 E	1745–1830	2	0
" 4	23 07 S, 54 50 E	0700–1600	1, 1 (reported)	0
" 13	24 10 S, 56 24 E	1030	1 (reported)	0
" 14	21 00 S, 57 00 E	0830–1130	1	145
	20 40 S, 57 07 E	1220–1420	1	100
" 29	21 43 S, 57 43 E	0825–0925	0	1
Apr. 17	16 43 S, 74 53 E	0825–1025	1	0
" 20	09 21 S, 75 08 E	1500	0	flock on horizon
" 28	01 34 N, 75 13 E	1400	1	0
" 29	03 54 N, 74 56 E	1100	0	2
" 30	06 51 N, 75 02 E	1030	1	100+
May 23	06 46 N, 55 00 E	1400–1600	0	8+
" 24	02 02 N, 51 11 E	0925–1125	0	275+
" 25	01 42 S, 45 46 E	0910–1110	0	500
" 31	06 05 S, 42 11 E	0915–1215	0	70
June 1	05 23 S, 48 08 E	0915–1215	0	360+
" 2	04 33 S, 54 17 E	0910–1210	0	180

TABLE 12.—*Weights (in grams) and measurements (in mm) of* Sterna vittata

Specimen	Age/Sex	Wing (arc)	Tail	Culmen	Tarsus	Weight
GI-315	ad. M	250	131	38	19	158.7
GI-316	imm. F	243	125	35	20.5	135.7
GI-317	ad. F	242	154	35	20	128.0
GI-318	ad. F	236	153	35	19	124.5
GI-319	ad. M	249	132	37.5	19.5	152.5
GI-320	imm. M	245	120	39.5	20.5	152.6
GI-321	ad F.	252	172	37	20	136.5
GI-322	ad. M	246	160	39	20	146.7
GI-323	imm. F	240	122	35	20	152.8
S. v. tristanensis [1]		258	172	36.5	19.5	
S. v. vittata [1]		267	139.5	33	18	

[1] Taken from Murphy, 1938, p. 16.

TABLE 13.—*Observations of* Gygis alba

Date	Location	Time	Number	Remarks
Feb. 5–6	08°00′ N, 54°58′ E	2200–0500	1?	reported
" 6	06 28 N, 55 04 E	2100	1+	heard several, saw one
" 7	03 54 N, 55 01 E	2100–2400	15+	heard and seen
" 8	01 59 N, 54 57 E	2100	1–2	
" 10	01 47 S, 54 56 E	2300	1	reported
" 11	03 20 S, 55 13 E	1745	6	
June 2	04 33 S, 54 17 E	0910–1210	24	

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